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Mazdoor Kisan Shakti Sangathan

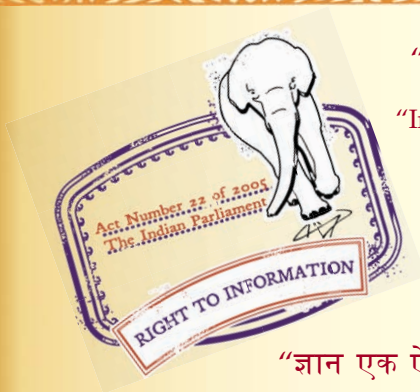
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“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 5475-1 (1978): Polystyrene Film Dielectric Capacitors,
Part I: General Requirements and Methods of Tests [LITD 5:
Semiconductor and Other Electronic Components and Devices]



“ज्ञान से एक नये भारत का निर्माण”

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“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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IS : 5475 (Part I) - 1978

Indian Standard

SPECIFICATION FOR
POLYSTYRENE FILM DIELECTRIC CAPACITORS

**PART I GENERAL REQUIREMENTS AND
METHODS OF TESTS**

(First Revision)

First Reprint MARCH 1990

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

SPECIFICATION FOR POLYSTYRENE FILM DIELECTRIC CAPACITORS

PART I GENERAL REQUIREMENTS AND METHODS OF TESTS

(First Revision)

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Indian Standard

SPECIFICATION FOR POLYSTYRENE FILM DIELECTRIC CAPACITORS

PART I GENERAL REQUIREMENTS AND METHODS OF TESTS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Part I) (First Revision) was adopted by the Indian Standards Institution on 5 May 1978, after the draft finalized by the Capacitors Sectional Committee had been approved by the Electronics & Telecommunication Division Council.

0.2 This standard (Part I) lays down the test methods and requirements for judging the electrical, mechanical and climatic properties of polystyrene film dielectric capacitors, primarily intended for dc applications.

0.3 This standard was originally published in 1969. Subsequently methods of tests for all types of capacitors are grouped in IS : 7305 (Part I)-1973*. This standard is revised with a view:

- a) to bringing it in line with latest IEC Documents on polystyrene film dielectric capacitors and IS : 7305 (Part I)-1973* which is a necessary adjunct to this standard;
- b) to reviewing the climatic categories, keeping in view the latest state of art;
- c) to reviewing the schedule of type tests and number of samples required;
- d) to reviewing the schedule of acceptance tests, AQL values, and inspection levels; and
- e) to improving certain performance requirements keeping in view the latest state of art.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

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0.4 While preparing this standard, assistance has been derived from the following:

IEC Doc: 40 (Central Office) 363 Sectional specification for fixed polystyrene film dielectric dc capacitors; Selection of methods of tests and general requirements. International Electrotechnical Commission.

JSS: 50211-1972: Detail specification for capacitors, fixed polystyrene dielectric. Directorate of Standardization, Department of Defence Production, Ministry of Defence, New Delhi.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part I) covers the requirements for fixed dc capacitors containing a dielectric of polystyrene film, intended for use in telecommunication equipment and in electronic devices employing similar techniques, but excluding capacitors for a reactive power exceeding 200 VAr.

1.2 The electrodes are either thin metal foils or thin layers of metal deposited on the dielectric. In the latter case, the capacitors shall exhibit no self-healing breakdown in the endurance test.

1.3 Capacitors for radio interference suppression are not included in this standard, but covered by IS : 3723 (Part I)-1978†.

2. TERMINOLOGY

2.0 For the purpose of this standard, the terms and definitions given in IS : 7305 (Part I)-1973‡, and those given below shall apply.

2.1 Stability Class — The tolerance on the temperature coefficient together with the permissible change of capacitance after defined tests. The stability class shall be stated in the relevant detail specification if required.

2.2 Rated Temperature Range — The range of ambient temperatures for which the capacitor is designed for continuous operation; this corresponds with the temperature limit of its appropriate category.

*Rules for rounding off numerical values (revised).

†Specification for capacitors for radio interference suppression: Part I General requirements and methods of tests (first revision).

‡Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

2.3 Temperature Coefficient — Variation in the value of the capacitance per unit degree rise of temperature per unit value of rated capacitance.

NOTE — The temperature coefficient is usually expressed in parts per million per degree Celsius. Symbolically representing,

$$= \frac{C_{t1} - C_{t2}}{C_{t1} (t_2 - t_1)} \times 10^6 \text{ ppm/}^\circ\text{C}$$

where

C_{t1} = capacitance value at t_1 $^\circ\text{C}$, and

C_{t2} = capacitance value at t_2 $^\circ\text{C}$.

3. CLIMATIC CATEGORIES

3.1 The polystyrene film dielectric capacitors covered in this standard are classified into climatic categories according to the general rules given in IS : 589-1961*.

3.2 Capacitors covered in this standard shall belong to one of the three preferred categories given in Table 1 based on their ability to withstand the corresponding climatic severities.

TABLE 1 CLIMATIC CATEGORIES

Sl. No.	CLIMATIC TEST (see IS : 589-1961*)	SEVERITIES			
		Category 1		Category 2	Category 3
		A	B		
(1)	(2)	(3)	(4)	(5)	(6)
i)	Dry heat	+ 70°C	+ 70°C	+ 70°C	+ 70°C
ii)	Cold	— 55°C	— 40°C	— 25°C	— 10°C
iii)	Damp heat (long term)	56 days	56 days	21 days	4 days
iv)	Damp heat (accelerated)	6 cycles	6 cycles	2 cycles	1 cycle
v)	Rapid change of temperature	+ 70°C to — 55°C	+ 70°C to — 40°C	+ 70°C to — 25°C	+ 70°C to — 10°C
vi)	Low air pressure	1 kPa	2 kPa	2 kPa	Not applicable

NOTE 1 — In cases where different combinations other than those specified is agreed, the severities for the cold, dry heat and damp heat (long term) tests shall be within the following ranges:

Cold : — 55°C to — 10°C

Dry heat : + 70°C

Damp heat : 04† to 56 days
(long term)

NOTE 2 — Assisted drying is conditioning for a period between 1 and 6 hours at a temperature of $55 \pm 2^\circ\text{C}$ and a relative humidity not exceeding 20 percent.

*Basic climatic and mechanical durability tests for electronic components (revised).

†With assisted drying, if required.

*Basic climatic and mechanical durability tests for electronic components (revised).

4. RATINGS

4.1 Rated Capacitance — The preferred values of the rated capacitance shall be chosen from E6, E12, E24, E48, E96 and E192 of IS : 824-1965*.

4.1.1 Tolerances on Rated Capacitance — The permissible tolerances on rated capacitances value shall be as follows:

E 6	± 20 percent
E 12	± 10 percent
E 24	± 5 percent
E 48	± 2 percent
E 96	± 1 percent
E 192	± 0.5 percent

NOTE — In any case the minimum tolerance shall be ± 1 pF. Additional values of capacitance outside the E192 range, and additional tolerances, may be specified in the relevant detail specification.

4.2 Rated Voltage — The values of dc rated voltage shall be chosen from the following:

25, 40, 63, 100, 160 and their decimal multiples.

NOTE — These values conform to R5 series of IS : 1076-1967†. The values 125, 200 and 500 V chosen from R10 series may be used for replacement purposes, for a period not longer than 5 years after this standard is published.

4.3 Temperature Coefficient — The nominal temperature coefficient with associated tolerances and values of permissible change of capacitance shall be as specified in Table 2.

TABLE 2 RATED TEMPERATURE COEFFICIENT

SL No.	TEMPERATURE COEFFICIENT AND TOLERANCE IN PARTS PER MILLION PER DEGREE CELSIUS ($10^{-6}/^{\circ}\text{C}$)				PERMISSIBLE CHANGE OF CAPACITANCE*
	- 80	- 100	- 125	- 160	
(1)	(2)	(3)	(4)	(5)	(6)
i)	± 20	± 25	± 30	± 40	± (0.3 percent + 0.3 pF)
ii)	± 40	± 50	± 60	± 80	± (0.5 percent + 0.5 pF)
iii)	± 60	± 70	± 80	± 100	± (0.75 percent + 0.75 pF)
iv)	—	—	± 125	± 160	± (1 percent + 1 pF)

*Permissible change of capacitance shall be measured after each of the following tests:

- Temperature cyclic drift (one cycle),
- Rapid change of temperature, and
- Endurance.

*Preferred value for resistors and capacitors (*revised*).

†Preferred numbers (*first revision*).

4.3.1 The Table 2 is not valid for capacitance values smaller than 50 pF.

5. CONSTRUCTION AND WORKMANSHIP

5.1 The construction, finish and workmanship shall be in accordance with 5 of IS : 7305 (Part I)-1973*.

6. DIMENSIONS

6.1 The dimensions shall be checked and shall comply with those specified in the relevant detail specification.

7. MARKING

7.1 The following marking information, in the order of importance given below, is required:

- a) Rated capacitance (may be indicated by the code given in IS : 8186-1976†.);
- b) Tolerance on rated capacitance (may be indicated by the code given in IS : 8186-1976†);
- c) Rated voltage : (direct voltage may be indicated by the symbol _____ or _____);
- d) Year and month (or week) of manufacture (may be indicated by the codes given in IS : 8186-1976†);
- e) Style reference (as specified in relevant detail specification);
- f) Manufacturer's name or trade-mark;
- g) Indication as to which termination is connected to the outside foil (where prescribed in the relevant detail specification);
- h) Manufacturer's type designation;
- k) Temperature coefficient and (if applicable) stability class; and
- m) Climatic category.

7.2 The capacitors shall be clearly marked with the items (a), (b), (c), and (g) and with as many as possible of the remaining items as is considered useful.

7.3 The package containing the capacitor(s) shall be clearly marked with (a), (b), (c), (d), (e), (f), (h), (k), and (m).

7.4 Any additional marking shall be so applied that no confusion can arise.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

†Marking codes for values and tolerance of resistors and capacitors.

7.5 The capacitors or their cartons may also be marked with the ISI Certification Mark.

NOTE—The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act, and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

8. TESTS

8.1 Classification of Tests

8.1.1 Type Tests

8.1.1.1 Type approval procedure—The procedure for type approval shall be in accordance with IS : 2612-1965*.

8.1.1.2 Number of samples—Unless otherwise specified, the number of samples shall be 60 for each voltage, comprising of the smallest case size and largest case size of 30 samples each. For each case size, the maximum capacitance shall be chosen.

8.1.1.3 Selection of samples—The samples shall be representative of the range of values of the type under consideration.

The number of specimen shall be so chosen that any part or sub-part subjected to a series of test shall be not less than five of a particular value, rating and type.

NOTE—A capacitor subjected to the type tests according to Table 3 or to any part of them which may be considered destructive, shall not be used in equipment nor be returned to bulk supply.

8.1.1.4 Schedule of type tests—The capacitors shall be subjected to the tests specified in Table 3, in the given order. After the completion of tests specified under group 0, the samples shall be divided into six groups for further testing.

8.1.2 Routine Tests—The following shall constitute the routine tests:

- a) Visual examination,
- b) Voltage proof (as a flash test), and
- c) Capacitance.

8.1.3 Acceptance Tests—Two groups of samples (Group A and Group B) shall be selected (see Appendix B of IS : 2612-1965*) from the lot which has passed the routine tests as specified in 8.1.2 and the capacitors in each group shall be subjected to the tests in the order given in Table 4.

*Recommendation for type approval and sampling procedures for electronic components,

TABLE 3 SCHEDULE OF TYPE TESTS

(Clauses 8.1.1.3 and 8.1.1.4)

GROUP	TITLE OF TEST	NUMBER OF SAMPLES EACH VOLTAGE RATING		CLAUSE REFERENCE
		Smallest Case Size	Largest Case Size	
(1)	(2)	(3)	(4)	(5)
0	Visual examination	30	30	8.4.1
	Dimension			8.4.2
	Voltage proof			8.3.1
	Capacitance			8.3.2
	Tangent of loss angle			8.3.3
	Insulation resistance			8.3.4
	Outer foil resistance			8.3.7
	Sealing (where applicable)			9.1
1	Robustness of terminations	6	6	8.4.3
	Resistance of soldering heat			8.4.4.2
	Solderability			8.4.4.1
	Rapid change of temperature			8.5.3
	Vibration			8.4.5
	Bump			8.4.6
	Shock			8.4.7
	Acceleration (steady state)			8.4.8
	Climatic sequence			8.5.1
2	Damp heat (long term)	6	6	8.5.2
3	Endurance	8	8	9.2
4	Mould growth	2	2	8.5.4
5	Resistance to solvents	3	3	9.4
6	Temperature coefficient and cyclic drift of capacitance	3	3	8.3.5
	Inductance (where required)			8.3.6
	Storage at low temperature			9.3
	Salt mist			8.5.5
Spares		2	2	

8.2 General Condition for Tests — The general condition for tests shall be as specified in 7.2 of IS : 7305 (Part I)-1973*.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

TABLE 4 SCHEDULE OF ACCEPTANCE TESTS

(Clause 8.1.3)

TEST	CLAUSE REF	AQL* (PERCENT DEFECTIVES)	INSPECTION* LEVEL	D/ND
(1)	(2)	(3)	(4)	(5)
GROUP A TESTS				
Dimensions	8.3.3 8.3.7 8.3.4 9.1	1 percent	II	ND
Tangent of loss angle				
Outer foil marking				
Insulation resistance				
Sealing (if applicable)				
GROUP B TESTS				
Sub Group 1				
Temperature coefficient	8.3.5	4 percent	S3	ND
Sub Group 2				
Solderability	8.4.4.1	4 percent	S3	D
Robustness of terminations	8.4.3			
Bump	8.4.6			
Climatic sequence	8.5.1			
Sub Group 3				
Endurance (168h)	9.2	4 percent	S3	ND
ND = Non-destructive. D = Destructive.				

ND = Non-destructive.

D = Destructive.

*See IS: 2500 (Part I)-1973 Sampling inspection tables: Part I Inspection by attributes and by count of defects (*first revision*).

8.3 Electrical Tests

8.3.1 Voltage Proof— This test shall be carried out in accordance with 7.3.1 of IS: 7305 (Part I)-1973*, with the following additional details/modifications:

- a) *Measuring condition*— A direct voltage of the value specified as follows shall be applied for a period of 1 minute ± 5 seconds between:
- 1) Terminations — $2 U_R$
 - 2) Terminations connected together and the case (where metallic) or metal foil wrapped over the body (where the capacitor is insulated) — $2 U_R$ with a minimum of 400 V

*Specification for fixed capacitors used in electronic equipment; Part I General requirements and tests.

NOTE — Voltage shall be applied at once through the internal resistance of the test apparatus and charge and discharge currents shall not exceed 50 mA.

- b) *Requirements* — The capacitors shall withstand this test without breakdown of flashover.

8.3.1.1 When this test is called for as a *flash test*, the dc voltage shall be applied for 2 seconds.

8.3.2 Capacitance — This test shall be carried out in accordance with 7.3.2 of IS : 7305 (Part I)-1973* with the following additional details/modifications:

- a) *Measuring conditions* — The capacitors shall be measured at the frequency mentioned below:

Capacitance Value	Standard Frequency	
	For Measurements	For Referee Purposes
$C \leq 1\,000\text{ pF}$	1 MHz \pm 20 percent	1 MHz \pm 20 percent
	or 100 kHz \pm 20 percent	
$C > 1\,000\text{ pF}$	1 kHz \pm 20 percent	1 kHz \pm 20 percent
	or 10 kHz \pm 20 percent	

The peak value, of the applied voltage shall not exceed 3 percent of the rated voltage or 5 V, whichever is the less.

NOTE — The measuring conditions shall be the same before and after a test.

- b) *Requirements* — The measured capacitance value shall be equal to the rated capacitance taking into account the tolerance and measurement errors.

NOTE — For capacitors with a value of less than 10 pF or of more than 1 μF , the method of measurement and the interpretation of the results shall be agreed upon between the purchaser and the manufacturer.

8.3.3 Tangent of the Loss Angle — This test shall be carried out in accordance with 7.3.3 of IS : 7305 (Part I)-1973* with the following additional details/modifications:

- a) *Measuring conditions* — See 8.3.2 (a);
- b) *Requirements* — The tangent of loss angle shall not exceed the following limits, taking into account the measurement errors, when measured at:
- 1) 1 MHz or 100 kHz : $5 \cdot 10^{-4}$ for $C \leq 1\,000\text{ pF}$
 - 2) 1 kHz or 10 kHz : $5 \cdot 10^{-4}$ for $C > 1\,000\text{ pF}$

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NOTE — When the rated capacitance is 10 pF or less, or higher than 1 μF , the limits shall be agreed upon between customer and manufacturer.

8.3.4 Insulation Resistance — This test shall be carried out in accordance with 7.3.6 of IS : 7305 (Part I)-1973*, with the following additional details/modifications:

a) *Measuring conditions* — The test voltage as given in Table 2 of IS : 7305 (Part I)-1973*, shall be applied between:

- 1) terminations, and
- 2) termination connected together and the case (where metallic) or the metal foil wrapped around the body (where the capacitor is insulated).

For measurement of very high insulation resistance between terminations of capacitors where both terminations are insulated from the container it is necessary to use a three terminal or guard ring method of measurement.

A suitable method is described in Appendix A.

NOTE — The voltage shall be applied immediately at the current value through the internal resistance of the voltage source. The product of internal resistance and of the rated capacitance shall not exceed 1 second or any other value prescribed in the detail specification.

When the test is carried out at a temperature other than 27°C the result shall, where necessary, be corrected to 27°C by multiplying the result of the measurement by the appropriate correction factor.

In cases of doubt, measurement at 27°C is decisive.

NOTE — The correction factors which may be considered as an average for polystyrene film dielectric capacitors are under consideration.

b) *Requirements* — The insulation resistance shall meet the following requirements:

Climatic Category (see 3.2)	Between Terminations		Between Terminations Connected Together and Case or Metal Foil Wrapped Over the Body R (Gr)
	$C > 0.1 \mu\text{F}$ R C (s)	$C \leq 0.1 \mu\text{F}$ R (Gr)	
1	50 000	500	500
2 and 3	10 000	100	100

NOTE — In the above table, *C* is the rated capacitance and *R*, the measured insulation resistance.

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8.3.5 Temperature Coefficient and Cyclic Drift of Capacitance — Under consideration.

8.3.6 Inductance (where required) — This test shall be carried out in accordance with 7.3.7 of IS : 7305 (Part I)-1973*. The inductance value shall be as specified in the relevant detail specification.

8.3.7 Outer Foil Termination (where applicable) — This test shall be carried out in accordance with 7.3.9 of IS : 7305 (Part I)-1973*.

8.4 Physical and Mechanical Tests

8.4.1 Visual Examination — The capacitance shall be visually examined for compliance with the requirements of marking and finish.

8.4.2 Dimensions — The dimensions of capacitors shall be checked for with these specified in the relevant detail specification.

8.4.3 Robustness of Terminations

8.4.3.1 This test shall be carried out in accordance with 7.4.3 of IS : 7305 (Part I)-1973*, with the following additional details/modifications:

- a) *Bending* — Not applicable to components with radial termination designed for printed wiring application. One bend only for ϕ 0.3 mm.
- b) *Torsion* — Not applicable to components with radial terminations designed for printed wiring applications.

8.4.4 Soldering

8.4.4.1 Solderability of terminations — This test shall be carried out in accordance with 7.4.4 of IS : 7305 (Part I)-1973*. The terminations shall get wet easily and the tinning should be uniform and good.

NOTE — The solderability of termination may be checked by the solder globule test method (under consideration). The requirements for this method shall be either prescribed in the relevant specification or shall be subject to agreement between the manufacturer and the purchaser.

8.4.4.2 Resistance to soldering heat — Unless otherwise specified, this test shall be carried out in accordance with 7.4.4 of IS : 7305 (Part I)-1973*, without any predrying.

The capacitor shall be visually examined after recovery under standard measuring condition; there shall be no visible damage or leakage of sealing material and the marking shall be legible. The capacitance shall then be measured and change of capacitance value shall be within

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the limits specified in the relevant specification. The tangent of loss angle shall be measured and shall not exceed the value specified in 8.3.3.

8.4.5 Vibration — This test shall be carried out in accordance with 7.4.5 of IS : 7305 (Part I)-1973* with the following additional details/modifications:

- a) *Mounting* — The mounting shall be prescribed in the relevant detail specifications.
- b) *Conditioning* — The severity shall be as specified in the relevant specification chosen from the following:

Frequency Hz	Peak Value of Vibration Amplitude ± 10 percent	Duration	Climatic Category (see 3.2)
10 to 2 000	0.75 mm or 20 g whichever is less	12 hours	1A
10 to 2 000	0.75 mm or 10 g whichever is less	9 hours	1B and 2
10 to 500	0.75 mm or 10 g whichever is less	6 hours	3

- c) *Measurements and requirements during testing* — The capacitors shall be loaded with rated voltage throughout the test. During the last half hour of vibration test in each direction electrical measurements shall be made on the capacitors to determine intermittent faults (open or short circuits). It is desirable that the detecting equipment shall detect any interruption with a duration of 0.5 millisecond or greater. There shall be no interruption.
- d) *Final inspection, measurements and requirements* — After the test the capacitor shall be visually examined and there shall be no mechanical damage. Marking shall be legible.

The capacitance, tangent of loss angle and leakage current shall be measured. The variation shall be within the limits specified in the relevant detail specification.

8.4.6 Bump — This test shall be carried out in accordance with 7.4.7 of IS : 7305 (Part I)-1973*, with the following additional details/modifications:

- a) *Mounting* — The mounting shall be as prescribed in the relevant detail specifications.

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- b) *Conditioning* — The degree of severity shall be:
 - 1) 4 000 bumps for category 1, and
 - 2) 1 000 bumps for categories 2 and 3.
- c) *Measurements and requirements during testing* — The capacitors shall be loaded with rated voltage throughout the test. During the last half hour of bump test, electrical measurements shall be made on the capacitors to determine intermittent faults (open or short circuits). It is desirable that the detecting equipment shall detect any interruption with a duration of 0.5 millisecond or greater. There shall be no interruption.
- d) *Final inspection, measurement and requirement* — After the test the capacitor shall be visually examined and there shall be no mechanical damage. Marking shall be legible.

The capacitance, tangent of loss angle and leakage current shall be measured. The variation shall be within the limit specified in the relevant specification.

8.4.7 Shock — This test shall be carried out in accordance with 7.4.8 of IS : 7305 (Part I)-1973* with the following additional details/modifications:

- a) *Mounting* — The mounting shall be as prescribed with the relevant detail specification.
- b) *Conditioning* — The degree of severity shall be as specified in the relevant detail specification.
- c) *Measurements and requirements during testing* — The capacitors shall be loaded with rated voltage throughout the test. During the last half hour of bump test, electrical measurements shall be made on the capacitors to determine intermittent faults (open or short circuits). It is desirable that the detecting equipment shall detect any interruption with a duration of 0.5 millisecond or greater. There shall be no interruption.
- d) *Final inspection, measurements and requirements* — After the test the capacitor shall be visually examined and there shall be no mechanical damage. Marking shall be legible.

The capacitance, tangent of loss angle and leakage current shall be measured. The variation shall be within the limit specified in the relevant specification.

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8.4.8 Acceleration — This test shall be carried out in accordance with 7.4.9 of IS : 7305 (Part I)-1973*, with the following additional details/modifications:

- a) *Mounting* — The mounting shall be as prescribed in the relevant detail specification.
- b) *Conditioning* — The degree of severity shall be as specified in the relevant detail specification.
- c) *Measurements and requirements during testing* — The capacitors shall be loaded with rated voltage throughout the test. During the last half hour of acceleration test, electrical measurements shall be made on the capacitors to determine intermittent faults (open or short circuits). It is desirable that the detecting equipment shall detect any interruption with a duration of 0.5 micro-second or greater. There shall be no interruption.
- d) *Final inspection, measurements and requirements* — After the test the capacitor shall be visually examined and there shall be no mechanical damage. Marking shall be legible.

The capacitance, tangent of loss angle and leakage current shall be measured. The variation shall be within the limit specified in the relevant specification.

8.5 Climatic Tests

8.5.1 Climatic Sequence — This test shall be carried out in accordance with 7.5.1 of IS : 7305 (Part I)-1973* with the following additional details/modifications.

8.5.1.1 Initial measurement — The capacitance, tangent of loss angle and insulation resistance shall be measured.

8.5.1.2 Dry heat — This test shall be carried out in accordance with 7.5.1.2 of IS : 7305 (Part I)-1973*. Duration of the test shall be 16 hours unless otherwise specified in the relevant detail specification.

After recovery the capacitors shall be visually examined. There shall be no visible damage and shall show no seepage of sealing material. Marking shall be legible.

8.5.1.3 Damp heat (accelerated) first cycle — This test shall be carried out in accordance with 7.5.1.3 of IS : 7305 (Part I)-1973* with no rated voltage applied.

After recovery the capacitors shall be visually examined. There shall be no visible damage and shall show no seepage of sealing material. Marking shall be legible.

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8.5.1.4 Cold — This test shall be carried out in accordance with 7.5.1.4 of IS : 7305 (Part I)-1973*. The duration of the exposure shall be 2 hours unless otherwise specified in the relevant detail specification.

During the last 10 minutes of the period of exposure the rated voltage shall be applied to the specimens.

After recovery the capacitors shall be visually examined. There shall be no visible damage and shall show no seepage of sealing material. Marking shall be legible.

The capacitor shall remain under recovery condition for 2 to 4 hours. They shall then be removed from the recovery chamber and shaken by hand to remove droplets of water.

8.5.1.5 Low air pressure — This test shall be carried out in accordance with 7.5.1.5 of IS : 7305 (Part I)-1973* with the following additional details/modifications:

- a) The test, if required in the detail specification shall be carried out at a temperature of 15 to 35°C and a pressure of 2 kPa unless otherwise stated in the relevant detail specification. The duration of the test shall be 1 hour.
- b) While still at the specified low pressure and during the last 5 minutes of the 1 hour period, the rated voltage shall be applied.
- c) During and after the test there shall be no evidence of permanent breakdown, flashover or harmful deformation of the case.

8.5.1.6 Damp heat (accelerated) remaining cycles — This test shall be carried out in accordance with 7.5.1.6 of IS : 7305 (Part I)-1973* with the following additional details/modifications:

- a) Within 15 minutes after the removal from the test chamber, the rated voltage shall be applied for 1 minute.
- b) After recovery the capacitor shall be visually examined. There shall be no visible damage. The marking shall be legible.

NOTE — The remaining damp heat cycles required are as follows:

Category 1	5 cycles
Category 2	1 cycle
Category 3	0 cycle

8.5.1.7 Final inspection, measurements and requirements

- a) After 1 to 2 hours recovery at standard atmospheric conditions for testing, the capacitor shall be visually examined. There shall be no visible damage and the marking shall be legible.

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- b) The capacitance, the tangent of loss angle and the insulation resistance shall then be measured.

- 1) The change in capacitance value shall not exceed the following values:

<i>Climatic Category (see 3.2)</i>	<i>Permissible Change in Capacitance</i>
1	$\pm (0.5 \text{ percent} + 1 \text{ pF})$
2	$\pm (1 \text{ percent} + 1 \text{ pF})$
3	$\pm (1.5 \text{ percent} + 1.5 \text{ pF})$

NOTE — For capacitance values smaller than 50 pF the maximum capacitance change is to be agreed between the purchaser and the manufacturer.

- 2) The tangent of loss angle shall not exceed the limits specified in 8.3.3.
- 3) The insulation resistance shall not be less than the following percentage of the values specified in 8.3.4.

<i>Climatic Category</i>	<i>Insulation Resistance as Percentage of Initial Requirement</i>
1	100 percent
2 and 3	50 percent

8.5.2 Damp Heat (Long Term) — This test shall be carried out in accordance with 7.5.2 of IS : 7305 (Part I)-1973* with the following additional details/modifications.

8.5.2.1 During the test, half the samples shall be loaded with rated voltage. Within 15 minutes after removal from the test chamber, the voltage proof test according to 8.3.1, but with the rated voltage applied, shall be made.

When specified in the detail specification the capacitors of category 3 shall be submitted to assisted drying according to Note 2 under Table 1. After the completion of assisted drying the capacitors shall be placed in standard atmospheric conditions for testing for 1 to 2 hours.

8.5.2.2 Final inspection, measurements and requirements

- a) After 1 to 2 hours recovery at standard atmospheric conditions for testing, the capacitors shall be visually examined. There shall be no visible damage and the marking shall be legible.

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- b) The capacitance, the tangent of loss angle and the insulation resistance shall then be measured.

- 1) The change in capacitance value shall not exceed the following values:

<i>Climatic Category (see 3.2)</i>	<i>Permissible Change in Capacitance</i>
1	$\pm (0.5 \text{ percent} + 1 \text{ pF})$
2	$\pm (1 \text{ percent} + 1 \text{ pF})$
3	$\pm (1.5 \text{ percent} + 1.5 \text{ pF})$

NOTE — For capacitance values smaller than 50 pF the maximum capacitance change is to be agreed between the purchaser and the manufacturer.

- 2) The tangent of loss angle shall not exceed the limits specified in 8.3.3.
- 3) The insulation resistance shall be not less than the following percentage of the values specified in 8.3.4:

<i>Climatic Category</i>	<i>Insulation Resistance as Percentage of Initial Requirement</i>
1	100 percent
2 and 3	50 percent

8.5.3 Rapid Change of Temperature — This test shall be carried out in accordance with 7.5.3 of IS: 7305 (Part I)-1973* with the following additional details/modifications:

- Number of cycles — 5.
- Duration of exposure at the temperature limit — 36 minutes.
- After 1 to 2 hour recovery under standard atmospheric conditions for testing, the capacitors shall be visually examined. There shall be no visible damage.
- The capacitance and the tangent of loss angle shall then be measured. The change of capacitance compared with the value measured in 8.3.2 shall not exceed the values given in Table 2. The change of capacitance for capacitance values smaller than 50 pF shall be agreed between the manufacturer and the purchaser.

The tangent of loss angle shall not exceed the value specified in 8.3.3.

8.5.4 Mould Growth — This test shall be carried out in accordance with 7.5.4 of IS: 7305 (Part I)-1973*. There shall be no visible damage.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

8.5.5 Salt Mist — This test shall be carried out in accordance with 7.5.5 of IS : 7305 (Part I)-1973*. The duration of the exposure shall be 4 days. The requirements shall be as stated in IS : 7305 (Part I)-1973*.

9. MISCELLANEOUS TESTS

9.1 Sealing (Hermetically Sealed Types) — This test shall be carried out in accordance with 7.5.6 of IS : 7305 (Part I)-1973*. There shall be no evidence of leakage of impregnant or filling compound.

9.2 Endurance — This test shall be carried out in accordance with 7.9 of IS : 7305 (Part I)-1973* with the following additional details/modifications:

- | | |
|--------------------------------|--|
| a) <i>Duration of the Test</i> | Category 1 — 2 000 hours with rated voltage applied
Category 2 and 3 — 1 000 hours |
| b) <i>Test Voltage</i> | 1.5 times the rated voltage ($1.5 U_R$) applied to the capacitors individually through a resistor with a maximum value of 1 200 Ω |
| c) <i>Temperature</i> | Upper category temperature |

9.2.1 Final Inspection, Measurement and Requirements

- a) After 1 to 2 hours recovery at standard atmospheric conditions for testing the capacitors are visually examined. There shall be no visible damage.
- b) The capacitance, the tangent of loss angle and the insulation resistance shall then be measured.
 - 1) The change in capacitance value shall not exceed the value given in Table 2.
 - 2) The tangent of loss angle shall not exceed the limit specified in 8.3.3 or 1.4 times the initial value measured, whichever is the greater.
 - 3) The insulation resistance shall meet the requirements as specified in 8.3.4.

9.3 Storage at Low Temperature — This test shall be carried out in accordance with 7.8.2 of IS : 589-1961†. Test conditions and requirements are under consideration.

9.4 Resistance to Solvents — This test shall be carried out in accordance with IS : 9000 (Part XX)‡.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

†Basic climatic and mechanical durability tests for components for electronic and electrical equipment (revised).

‡Basic environmental testing, procedures for electronic and electrical items: Part XX Resistance to cleaning solvents and permanence of markings (under preparation).

APPENDIX A

(Clause 8.3.4)

METHOD FOR MEASUREMENT OF VERY HIGH INSULATION RESISTANCE BETWEEN TERMINATIONS

In the measuring circuit, the capacitor whose insulation resistance is to be measured is connected across the two terminals *A* and *B*, of Fig. 1A and so placed in series with a battery and a galvanometer, the galvanometer reading being a measure of the resistance.

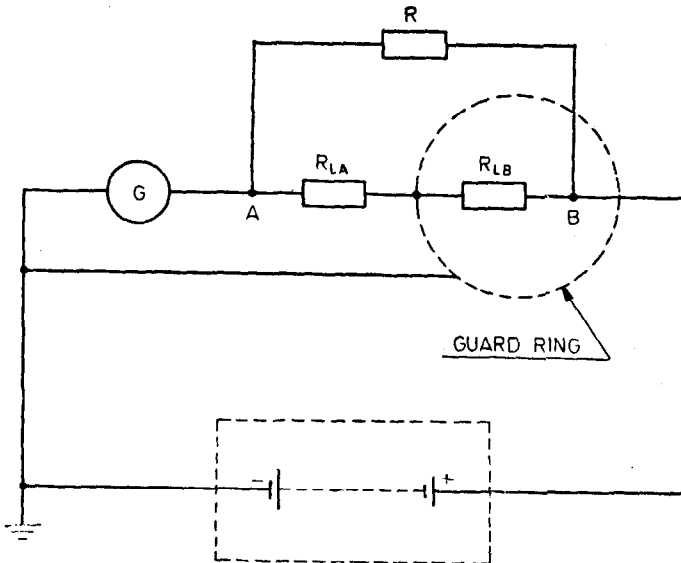
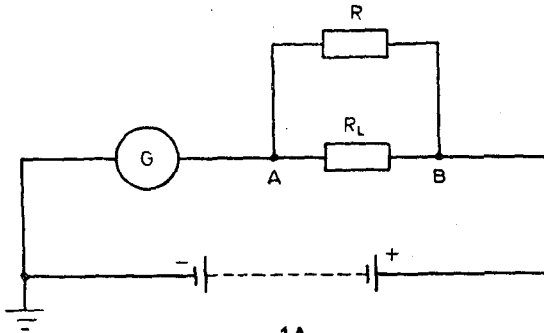


FIG. 1. MEASUREMENT OF VERY HIGH INSULATION RESISTANCE

If terminals *A* and *B* have imperfect insulation so that there is a leakage R_L across them, this will upset the measurement of R unless this is appreciably lower than R_L since the leakage resistance is in parallel with that to be measured. The adverse effect of R_L may be obviated by surrounding the live terminal *B* with a metal ring which is in contact with the insulating material of the terminal bushing and which is also connected to the earthing side of the battery.

The leakage resistance R_L is then effectively divided into two parts R_{LA} and R_{LB} . Of those parts R_{LB} is, as will be seen from Fig. 1B connected in parallel with the battery and hence cannot effect the galvanometer reading. Similarly, R_{LA} connected in parallel with the galvanometer and since R_{LA} is of the order of at least hundreds of megohms, the effect of its shorting the galvanometer is entirely negligible.

A further cause of error is direct from the battery to terminal *A*. This may be obviated by placing the battery on a metal plate which is also connected to the earthed side of the battery.

Although the system has been described with a galvanometer as the indicator, it may equally be connected to an electronic measuring set.

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